Appendix D:

Basement Impact Assessment Report – GEA Ltd

DESK STUDY, GROUND INVESTIGATION AND GROUND MOVEMENT ASSESSMENT REPORT

2 Hyde Park Place
London
W2 2LH

Client: Synergy Lifestyle Limited

J20200

November 2020

GEA

Document Control

Project title	2 Hyde Park Place, London W2 2LH		Project ref	J20200
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Issue No	Status	Amendment Details	Date	Approved for Issue
1	Final		13 November 2020	[signature]

This report has been issued by the GEA office indicated below. Any enquiries regarding the report should be directed to the project engineer at the office indicated below or to Steve Branch in our main Herts office.

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This report is intended as a Ground Investigation Report (GIR) as defined in BS EN1997-2, unless specifically noted otherwise. The report is not a Geotechnical Design Report (GDR) as defined in EN1997-2 and recommendations made within this report are for guidance only.

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Part 3: GROUND MOVEMENT ASSESSMENT

EXECUTIVE SUMMARY

This executive summary contains an overview of the key findings and conclusions. No reliance should be placed on any part of the executive summary until the whole of the report has been read. Other sections of the report may contain information that puts into context the findings that are summarised in the executive summary.

BRIEF

This report describes the findings of a site investigation carried out by Geotechnical and Environmental Associates Limited (GEA) on behalf of Synergy Lifestyle Ltd, with respect to the construction of a basement beneath the lower ground floor of the existing property. The purpose of the investigation has been to determine the ground conditions and hydrogeology, to carry out an assessment of ground movements resulting from excavation of the proposed basement, to assess the extent of any contamination and to provide information to assist with the design of the basement structure and suitable foundations. The report also includes information required to comply with City of Westminster planning guidance with respect to basement construction.

DESK STUDY FINDINGS

The desk study findings indicate that the site has been developed with a house since at least 1869, with the existing house present since at least 1895. The site and immediate surrounding area have only had a residential use for the entire known developed history and are therefore not considered to have a significantly potentially contaminative history. No sources of soil gas have been identified on site or in the surrounding area. There is, therefore, assessed to be a VERY LOW RISK of there being a significant contaminant linkage present at this site that could lead to a requirement for remediation.

GROUND CONDITIONS

Below a variable but limited thickness of made ground, Lynch Hill Gravel was encountered over London Clay, which was proved to the full depth of the investigation. The made ground was of variable composition, with fragments of brick and coal, and extended to depths of between 0.40 m (21.89 m OD) and 0.90 m (21.58 m OD). The Lynch Hill Gravel generally comprised brown or yellowish brown clayey silty gravelly sand, which became silty sandy slightly gravelly clay with depth, and extended to depths of between 1.00 m (21.11 m OD) and 1.70 m (20.78 m OD). The London Clay comprised firm to stiff fissured clay with selenite and occasional pockets of silt, and was proved to the maximum depth of the investigation, of 10.00 m below lower ground floor level (12.11 m OD). Groundwater was not encountered during the investigation, but has subsequently been monitored at a shallowest depth of 0.33 m (21.96 m OD) within the gravel. Contamination testing has revealed the presence of an elevated concentration of lead within the made ground.

RECOMMENDATIONS

Formation level for the proposed basement is likely to be within the firm to stiff London Clay, which should provide an eminently suitable bearing stratum for spread foundations. Excavations for the proposed basement structure will require temporary support to maintain stability and to prevent any excessive ground movements. Perched water is likely to be encountered within the made ground and groundwater should be anticipated within the Lynch Hill Gravel. This should be accounted for in the construction methodology and design, and dealt with by sump pumping during construction.

The lead contamination is attributed to coal within the made ground and will be removed during construction of the basement. A programme of working should be identified to protect site workers.

GROUND MOVEMENT ASSESSMENT

The ground movement analysis has concluded that the predicted damage to the neighbouring properties would be 'Negligible' to 'Very slight', such that the damage that has been predicted to occur as a result of the construction of the proposed basement falls within the acceptable limits.

Part 1: INVESTIGATION REPORT

This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Interpretation of the findings is presented in Part 2 and an assessment of the ground movements associated with the basement excavation is included in Part 3.

1.0 INTRODUCTION

Geotechnical and Environmental Associates Limited (GEA) has been commissioned by Synergy Lifestyle Ltd to carry out a desk study, ground investigation and ground movement assessment at 2 Hyde Park Place, London W2 2LH.

The consulting structural engineers are Duffy Associates.

1.1 Proposed Development

It is understood that it is proposed to construct a single level basement beneath the existing lower ground floor of the building, which will include a swimming pool.

This report is specific to the proposed development and the advice herein should be reviewed if the proposals are amended.

1.2 Purpose of Work

The principal technical objectives of the work carried out were as follows:

- to determine the history of the site and surrounding area, particularly with respect to any previous or present potentially contaminative uses;
- to assess the risk of encountering unexploded ordnance (UXO);
- to determine the ground conditions and their engineering properties;
- to provide advice and information with respect to the design of suitable foundations and retaining walls;
- to assess the impact of the proposed basement on the local hydrogeology, hydrology and stability of the surrounding natural and build environment;
- to provide an indication of the degree of soil contamination present; and
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

1.3 Scope of Work

In order to meet the above objectives, a desk study was carried out, followed by a ground investigation. The desk study comprised:

- a review of historical Ordnance Survey (OS) maps and environmental searches sourced from the Envirocheck database;

- a review of readily available geology maps;
- a walkover survey of the site carried out in conjunction with the fieldwork; and
- commissioning of 1st Line Defence to undertake preliminary and detailed UXO risk assessments;

In light of this desk study an intrusive ground investigation was carried out which comprised, in summary, the following activities:

- a single borehole advanced to a depth of 10.00 m (12.11 m OD) using an opendrive percussive sampler;
- two window sampler boreholes advanced to depths of 8.40 m (14.08 m OD) and 2.00 m (20.29 m OD);
- installation of three groundwater monitoring standpipes, to depths of between 1.00 m and 2.00 m (21.11 m OD and 20.48 m OD) and a subsequent programme of groundwater monitoring, comprising two visits in total;
- testing of selected soil samples for contamination and geotechnical purposes; and
- provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

This report includes a contaminated land assessment which has been undertaken by a suitably qualified and competent professional in accordance with the methodology presented by the Environment Agency in their Land contamination risk assessment (LCRM)[1] published 8 October 2020. This involves identifying, making decisions on, and taking appropriate action to deal with, land contamination in a way that is consistent with government policies and legislation within the United Kingdom. Risk management is divided into three stages; Risk Assessment, Options Appraisal and Remediation, and each stage comprises three tiers. The Risk Assessment stage includes preliminary risk assessment (PRA), generic quantitative risk assessment (GQRA) and detailed quantitative risk assessment (DQRA)and this report includes the PRA and GQRA.

The work has also been carried out to address the requirements of Policy CM28.1[2] of Westminster's City Plan, dated July 2016. The aim of the work is to provide information on land stability and groundwater and in particular to assess whether the development will affect the stability of neighbouring properties or groundwater movements and whether any identified impacts can be appropriately mitigated by the design of the development. This includes the following items and the sections of the report that address with each requirement are shown in brackets;

- a thorough desk study (Part 1);
- a site investigation which can be demonstrated to be relevant to the site (Section 3.0 to Section 4.5);
- an analysis of the Upper Aquifer (when present) and how the basement may impact on any groundwater flow (Section 2.6 and Section 7.2);

1 https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm
2 City of Westminster (2016) *Westminster's City Plan: Consolidated with Basement and Mixed Use Revisions*

- consideration of flood risk, surface water flooding (Section 2.6); and
- an assessment of movements expected and how these will affect adjoining or adjacent properties (Part 3).

The exploratory methods adopted in this investigation have been selected on the basis of the constraints of the site including but not limited to access and space limitations, together with any budgetary or timing constraints. Where it has not been possible to reasonably use an EC7 compliant investigation technique a practical alternative has been adopted to obtain indicative soil parameters and any interpretation is based upon engineering experience, local precedent where applicable and relevant published information.

1.4 Limitations

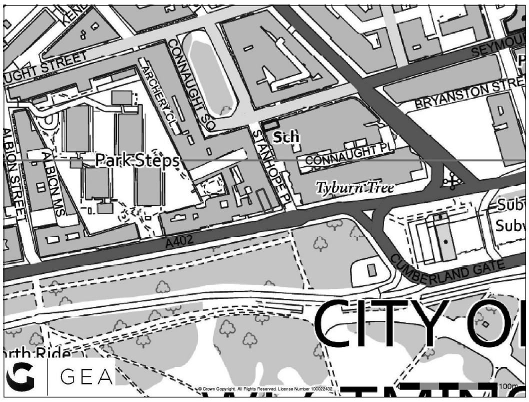
The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or ground water samples tested. No liability can be accepted for conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from third parties are given in good faith on the assumption that the information is accurate; no independent validation of third party information has been made by GEA.

2.0 THE SITE

2.1 Site Description

The site is located in the City of Westminster, on the northern edge of Hyde Park, roughly 325 m west of Marble Arch London Underground Station. It fronts onto Hyde Park Place, also called Bayswater Road, to the south and is bounded to the east and west by Nos 1 and 3 Hyde Park Place, which comprise six-storey buildings along the Hyde Park Place frontage. No 1 Hyde Park Place is known to have an existing basement beneath the lower ground floor level. The site is bounded to the north by No 1 Stanhope Place, a five-storey residential building, with Frederick Close leading off Stanhope Place a short distance beyond. The site may be additionally located by National Grid Reference 527560, 180960 and is shown on the map extract overleaf.

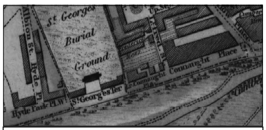
A walkover of the site was carried out by a geotechnical engineer from GEA at the time of the fieldwork. The site is rectangular in shape and measures approximately 30 m north-south by 9 m east-west. It is occupied by a six-storey house, which was vacant at the time of the walkover. A short flight of steps leads up from pavement level (around 24 m OD) to the ground floor, which is at around 25.85 m OD, and adjacent steps lead down to a lightwell at 22.11 m OD, and the lower ground floor, which is at a level of around 22.47 m OD. The site is entirely occupied by the existing building and is devoid of vegetation, although mature London plane trees are located in the pavement along Hyde Park Lane, at the front of the property.



2.2 Site History

The history of the site and surrounding area has been researched by reference to archive historical maps and Ordnance Survey (OS) maps sourced from the Envirocheck database.

Greenwood's map of London, dated 1827, shows that Hyde Park Place and Stanhope Place were named Lower Frederick Street and Lower Connaught Place respectively at that time, with Frederick Mews, now Frederick Close, to the north. A building that may have included the site footprint is shown at the junction of Lower Frederick Street and Lower Connaught Place, with open land to the rear, south of Frederick Mews. Hyde Park, which was a hunting ground for Henry VIII in 1536 before opening to the public in 1637[3], is shown to the south of Lower Connaught Place, with St George's Burial Ground a short distance to the west.



Extract from Greenwood's Map of London, 1827

The earliest Ordnance Survey map studied, dated 1869, shows that all the local street frontages were developed with terraced properties by this time. Lower Connaught Place had been renamed Connaught Place West, and the site was entirely covered by buildings. St George's Burial Ground is annotated as closed.

The 1872 map suggests that the rear third of the site was covered by a building that was separate to the one on the front part of the site. By 1895, the building on site was clearly of

3 Weinreb, B & Hibbert, H (1983) *The London Encyclopaedia*

the existing configuration, with the courtyard and front lightwell clearly visible on the 1895 map. The row of houses had been renamed again, with St George's Terrace and Connaught Place West collectively annotated as Hyde Park Place.

The 1916 map shows a convent located four houses to the west, at No 6 Hyde Park Place.

As further discussed at Section 2.4, during World War II (WWII), at least one bomb is recorded to have struck within or immediately adjacent to the site boundary, and London County Council damage mapping records areas of the site as having been 'damaged beyond repair' and 'seriously damaged, doubtful if repairable'. This damage is not evident on the historical mapping and is presumed to have been repaired post war.

An aerial photograph, dated 1949, shows that tennis courts had been installed on the disused St George's Burial Ground by this time. These remained until some time between 1968 and 1973, when the four existing apartment blocks were built.

Reference to planning records published online by City of Westminster and dating back to 1984, indicate that both the site and the adjacent properties of Nos 1 and 3 Hyde Park Place have been wholly or partially used as commercial offices at various times, and as both single dwellings and multiple flats, with conversions between residential and business use and associated internal and minor external remodelling. In addition to permission for construction of a basement beneath No 1 Hyde Park Place, the records show permissions for alterations to No 3, including the replacement of the roof and erection of an additional storey. However, no planning permission for a basement beneath No 3 is evident. Documentation dated January 2008 pertaining to the construction of a single storey basement beneath the full footprint of No 1 Hyde Park Place has been provided by the client, and it is understood that the basement has since been constructed. Immediately to the north of the site, the planning records indicate that No 1 Stanhope Place has been subdivided into flats, but no permission for the construction of a basement beneath the property is listed.

2.3 Other Information

A search of public registers and databases has been made via the Envirocheck database and relevant extracts from the search are appended. Full results of the search can be provided if required.

The search has revealed that there are no current or historical landfill sites, and no areas of potentially infilled land, within 1 km of the site. The nearest waste transfer and licensed waste management facility is located around 823 m to the northwest of the site, at St Mary's Hospital, but the licences for these activities are listed as surrendered. The nearest operational registered waste transfer site is located 933 m to the northwest of the site.

The search has indicated that the site is located in an area where less than 1% of homes are affected by radon emissions; which is the lowest classification given by the Health Protection Agency (HPA) and therefore no radon protective measures will be necessary.

An inactive lighting manufacturers is listed 15 m to the west of the site in the Contemporary Trade Directory, at No 4 Hyde Park Place. Several business are listed at 17 Connaught Place, around 91 m to the northeast, but potentially polluting activities connected with the businesses listed are considered unlikely to occur at this location, which is an office block rather than manufacturing or service premises.

The nearest fuel station listed is 278 m to the northwest of the site, recorded as obsolete, and there are no others within 500 m. However, a petrol filling station 139 m to the north, at

Hertz Rent A Car, is the subject of an authorised Local Authority Pollution Prevention and Control permit.

The site is not located within a nitrate vulnerable zone or any other sensitive land use.

There is an active discharge consent, and two revoked consents, for the discharge of cooling water into a borehole at a site 155 m to the east. Discharges at this location are unlikely to affect the site. Water abstraction is consented at 4 Connaught Place, 124 m to the northeast of the site.

London Underground Central Line Tunnels run beneath Hyde Park Place / Bayswater Road, approximately 8 m away from the site boundary. Copies of the service search information are included within the appendix.

2.4 Unexploded Ordnance (UXO) Risk Assessment

Preliminary and Detailed UXO Risk Assessments (report ref EP11941-00, dated 23rd September 2020 and report ref DA11941-00, dated 16th October 2020), have been completed by 1st Line Defence, and the reports are included in the appendix. The risk assessments have been carried out in accordance with the guidelines provided by CIRIA[4], which state that the likelihood of encountering and detonating UXO below a site should be assessed along with establishing the consequences that may arise. The first phase comprises a preliminary risk assessment, which should be undertaken at an early stage of the development planning. If such an assessment identifies a high level of risk then a detailed risk assessment should be carried out by a UXO specialist, which will identify an appropriate course of action with regard to risk mitigation.

The reports indicate that, during World War II (WWII), the site was located within the Metropolitan Borough of Paddington, which sustained a very high bomb density. A high explosive bomb struck No 4 Hyde Park Place in 1941, and Nos 4-7 were subsequently cleared. The site sustained blown-out windows and minor roofing damage but otherwise appears to have escaped more serious damage. Although it is within the distance whereby unexploded ordnance might have penetrated the destroyed buildings and come to rest beneath the site, it is considered that the intervening basements would have prevented this.

Based on the available evidence, the report recommends that all intrusive works at the site are subject to a UXO Risk Management Plan, with site specific UXO awareness briefings given to all personnel conducting intrusive works. However, the level of risk is not considered high enough to warrant supervision by a UXO specialist. These conclusions will need to taken into account during the redevelopment.

2.5 Geology

The British Geological Survey (BGS) map of the area indicates the site is underlain directly by London Clay, with superficial deposits of Lynch Hill Gravel surrounding the site. These may extend partially beneath the site.

According to the BGS memoir, the Lynch Hill Gravel comprises sand and gravel, locally with lenses of silt, clay or peat, and the London Clay is homogenous, slightly calcareous silty clay to very silty clay, with some beds of clayey silt grading to silty fine-grained sand.

4 CIRIA C681 (2009) *Unexploded ordnance (UXO) A guide for the construction industry*

A factual report of a previous ground investigation at No 1 Hyde Park Place, immediately to the east of the site, by Chelmer Site Investigations in September 2007, has been supplied by the client. This shows that made ground, comprising dark brown silty and very silty clay with gravel and brick fragments, variously with roots, was encountered to depths of between 0.215 m and 0.92 m below basement level. Beneath this, the soil initially comprised firm to stiff brown and orange sandy gravelly silty clay or clayey silt, with partings of silt, sand and gravel and occasional claystone nodules, to depths of 2.40 m and 3.50 m. Beneath this depth, very stiff silty clay with partings of silt and fine sand extended to the maximum depth investigated, of 10.00 m.

GEA has previously carried out a ground investigation at No 14 Stanhope Place, located roughly 40 m to the northeast of the site. The investigation encountered a limited thickness of made ground, overlying Lynch Hill Gravel, to the full depth of investigation of 2.30 m beneath the front lightwell. The made ground extended to a depth of 0.90 m, below which the Lynch Hill Gravel comprised brown clayey very sandy gravel of flint to a depth of 2.30 m, with an intervening layer of firm orange-brown mottled grey silty sandy slightly gravelly clay, from 1.60 m to 2.00 m.

A search of the British Geological Survey records has identified records of a borehole, ref TQ28SE395, drilled at the corner of Hyde Park Place and Stanhope Place, roughly 20 m to the southeast of the site. This encountered made ground to a depth of 2.90 m over 'yellow clay' to a depth of 9.45 m, terminating in 'blue clay'.

Records of two further deep borehole records have been obtained from the BGS archives. Boreholes ref TQ28SE2215 and TQ28SE2216 were drilled around 120 m and 140 m to the east of the site, at Nos 4 and 1 Connaught Place respectively, and the records simply state that London Clay was encountered to depths of 55 m and 58 m, over Lambeth Group to 70 m and 69 m, over Thanet Sand to 72 m and 71.4 m. Beneath this, 'cobbled flint beds' were encountered in borehole TQ28SE2216 to 71.8 m, underlain by chalk, which extended to the full depth of drilling in both boreholes, of 128.5 m.

2.6 Hydrology and Hydrogeology

The Lynch Hill Gravel is classified as a Secondary 'A' Aquifer, which refers to permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

The London Clay is classified by the Environment Agency (EA) as Unproductive Stratum, referring to rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. The London Clay is not capable of supporting a groundwater table, although isolated pockets of perched groundwater do occur within fissures and silt and sand partings. Published data for the permeability of the London Clay indicates the horizontal permeability to range between 1×10^{-11} m/s and 1×10^{-9} m/s, with an even lower vertical permeability.

At the time of the site walkover, eight trial pits, previously excavated by others, were open across the site. Two of the pits, both located along the western party wall with No 3, contained standing water at levels of 21.37 m OD and 21.52 m OD, and a third pit along the same boundary wall was dry to the base at 21.74 m OD. The remaining pits were also dry, but to levels of between 21.16 m OD and 21.91 m OD, such that two of the pits on the boundary with No 1 Hyde Park Place were dry to a deeper level than the pits containing water on the boundary with No 3. This suggests that water is perched at the base of the foundations.

The dry pits on the boundary with No 1 may be a result of the basement construction beneath No 1 having facilitated drainage around the foundations along this party wall.

During the aforementioned GEA investigation at 14 Stanhope Place, groundwater was encountered during drilling at a depth of 1.16 m and subsequently measured at a depth of 1.15 m beneath the front lightwell, within the Lynch Hill Gravel.

The boreholes drilled at No 1 Hyde Park Place were dry or only moist at the base during drilling, and the groundwater monitoring results are not recorded on the available logs.

No groundwater is reported in BGS borehole ref TQ28SE395, drilled at the corner of Hyde Park Place and Stanhope Place, roughly 20 m to the southeast of the site.

In BGS borehole ref TQ28SE2215, groundwater was struck at a depth of 76 m, with a rest level on completion at a depth of 68.55 m. In BGS borehole ref TQ28SE2216, groundwater was struck at a depth of 77 m, with a rest level on completion of 69.05 m. Both rest levels are within the Lambeth Group soils.

The site is not within an area shown by the Environment Agency to be at risk from flooding from rivers or the sea, nor is it located within a Groundwater Source Protection Zone as defined by the Environment Agency. It is not shown on the EA surface water flood maps, as being in an area with a potential risk from surface water flooding, although it is immediately adjacent to such an area.

Reference to the Lost Rivers of London[5] indicates that the site is located over a former tributary of the River Westbourne, hence the morphology of the superficial deposits beneath and immediately around the site. The tributary flowed southwards, joining the main channel of the River Westbourne part way along the Serpentine, within Hyde Park.

The Envirocheck search indicates that the nearest surface water feature is Paddington Basin, located 472 m to the northwest of the site.

The nearest pollution incident to controlled waters occurred 648 m to the south of the site, in 1998, and was a Category 3 – Minor Incident. This is downstream of the site.

The existing site is entirely covered by the building and concrete hardstanding within the lightwell. Infiltration of rainwater is therefore restricted to surface water drains, such that surface runoff currently drains into combined sewers in the road.

As the development does not result in a change to the present conditions, for example through the loss of any permeable areas, there will not be an increase in runoff rate or volume into the existing sewer system, or that could have a potentially adverse impact on the surrounding area. There should not, therefore, be any requirement for any mitigation measures. Mitigation measures are unlikely to be feasible in any case, due to a lack of available space and little opportunity to reduce runoff rates from the site via attenuation or rainwater harvesting, or to temporarily retain surface water flows using rain gardens or permeable paving.

[5] Nicholas Barton and Stephen Myers (2016) *London's Lost Rivers. Revised Edition.* Historical Publications Ltd

2.7 Preliminary Contamination Risk Assessment

Part IIA of the Environmental Protection Act 1990, which was inserted into that Act by Section 57 of the Environment Act 1995, provides the main regulatory regime for the identification and remediation of contaminated land. The determination of contaminated sites is based on a "suitable for use" approach which involves managing the risks posed by contaminated land by making risk-based decisions. This risk assessment is carried out on the basis of a source-pathway-receptor approach.

2.7.1 Source

The desk study research has indicated that the site has been developed since the mid-19th Century and has only ever had a residential or office use for its entire known developed history, as have the adjoining buildings. It is therefore not considered to have had a significantly potentially contaminative history. The maps suggest that the house may have been rebuilt or reconfigured between 1872 and 1895, and a thickness of made ground can be expected beneath the site.

No sources of soil gas have been identified on the site or in the surrounding area.

2.7.2 Receptor

The building will continue to have a residential use, and end users will represent relatively high sensitivity receptors, as at present. Buried services are likely to come into contact with any contaminants present within the soils through which they pass, and site workers are likely to come into contact with any contaminants present during construction works. The Secondary 'A' Aquifer close to the site is also a sensitive receptor.

2.7.3 Pathway

Within the site, end users will be isolated from direct contact with any contaminants present within the made ground by the building, and thus no potential contaminant exposure pathways will exist with respect to end users.

There will be a potential for contaminants to move onto or off the site horizontally within the made ground and any underlying gravel, although these pathways are already in existence. A pathway for ground workers to come into contact with any contamination will exist during construction work and services will come into contact with any contamination within the soils in which they are laid.

There is thus considered to be a low potential for a contaminant pathway to be present between any potential contaminant source and a target for the particular contaminant.

2.7.4 Preliminary Risk Appraisal

On the basis of the above it is considered that there is a VERY LOW risk of there being a significant contaminant linkage at this site, which would result in a requirement for major remediation work. Furthermore, as there is no evidence of filled ground within the vicinity of the site and no nearby landfill sites or other significant potential sources of ground gas, there is not considered to be a potential for hazardous soil gas to be present on or migrating towards the site.

3.0 EXPLORATORY WORK

In order to meet the objectives described in Section 1.2, as far as possible within the access limitations presented by the house, a single borehole was drilled within the front lightwell, from a level of 22.11 m OD to a depth of 10.00 m (12.11 m OD), using an opendrive percussive sampler, and two boreholes were drilled towards the rear of the property, at lower ground floor level, using a window sampler, one from a level of 22.48 m OD to a depth of 8.40 m (14.08 m OD) and one from 22.29 m OD to 20.29 m OD (2.00 m deep).

Groundwater monitoring standpipes were installed into each of the three boreholes to depths of between 1.00 m and 2.00 m (21.11 m OD and 20.48 m OD), to facilitate a subsequent programme of groundwater monitoring, comprising two visits in total.

A selection of the disturbed samples recovered from the boreholes was submitted to a soil mechanics laboratory for a programme of geotechnical testing and an analytical laboratory for a programme of contamination testing.

All of the work was carried out under the supervision of a geotechnical engineer from GEA. The Detailed UXO Risk Assessment had not been completed at the time of the fieldwork and therefore, in accordance with the recommendations of the Preliminary UXO Risk Assessment, the works were also carried out under the supervision of a UXO specialist, with magnetometer scanning of the boreholes carried out during drilling.

The borehole records are appended, together with the results of the laboratory testing and a site plan indicating the borehole locations. The Ordnance Datum (OD) levels on the borehole and trial pit records have been interpolated from levels shown on drawing ref 0010-00, dated 2015, by iArchitecture, which was provided by the client.

3.1 Sampling Strategy

The boreholes were positioned on site by an engineer from GEA in accessible areas, with due regard to the proposed development and the locations of known buried services, in consultation with the client.

Four samples of the shallow soil (three of made ground and a single sample of natural soil) were subjected to analysis for a range of common industrial contaminants and contamination indicative parameters. For this investigation the analytical suite for the soil and water included a range of metals, total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), total cyanide and monohydric phenols. Four samples of made ground were also screened for the presence of asbestos.

The soil samples were selected to provide a general view of the chemical conditions of the soils that are likely to be involved in a human exposure or groundwater pathway and to provide advice in respect of re-use or for waste disposal classification. The contamination analyses were carried out at a MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards.

A number of the disturbed samples of natural soil were submitted to a geotechnical testing laboratory and were subject to a number of material property tests, including four-point Atterberg Limits, moisture content tests and particle size distribution tests (PSD).

4.0 GROUND CONDITIONS

The investigation has confirmed the expected ground conditions in that, below a limited thickness of made ground, Lynch Hill Gravel was encountered over London Clay, which was proved to the full depth of the investigation.

Despite the relative proximity of Borehole No 1 to mature London plane trees planted in the adjacent pavement, no roots were noted within the soils and there was no visual evidence of desiccation.

4.1 Made Ground

Beneath a variable thickness of concrete surfacing, the composition of the made ground varied across the site, being primarily granular beneath the front lightwell and internal courtyard (Borehole Nos 1 and 3), and dominantly cohesive at the rear of the site, in Borehole No 2. It variously contained fragments of brick and concrete, with occasional slate, coal and ceramic pipe and rare plastic fragments also encountered, and extended to depths of between 0.40 m (21.89 m OD) and 0.90 m (21.58 m OD).

Other than the fragments of extraneous material, no visual or olfactory evidence of contamination was identified during the fieldwork. As a precaution, three samples of the made ground were tested for the presence of contamination and the results are presented in Section 4.5.

4.2 Lynch Hill Gravel

The Lynch Hill Gravel generally comprised brown or yellowish brown silty sandy slightly gravelly clay. In Borehole No 1 there was an initial layer of silty gravelly sand, in which the gravel was of fine to coarse angular to rounded flint / chert, but this initial layer graded to clay within 0.40 m. The stratum extended to depths of between 1.00 m (21.11 m OD) and 1.70 m (20.78 m OD).

The results of plasticity index tests indicate the clay to be of low to high volume change potential.

This stratum was observed to be free of evidence of contamination. As a precaution, a single sample of the gravel was tested for the presence of contamination and the results are presented in Section 4.5.

4.3 London Clay

The London Clay comprised firm to stiff fissured brown mottled grey clay with selenite and occasional pockets of yellowish brown silt, particularly in the upper 2.0 m to 3.5 m, and became stiff and greyish brown with depth. It extended to the maximum depth investigated of 10.00 m below lower ground floor level (12.11 m OD).

The results of plasticity index tests indicate the clay to be of high volume change potential.

This stratum was observed to be free of evidence of contamination.

4.4 Groundwater

Groundwater was not encountered during drilling. Two of the eight trial pits previously excavated by others, which were open at the time of the investigation, contained standing water at levels of 21.37 m OD and 21.52 m OD. However, the fact that other, deeper pits were dry, suggests that this water was perched, as described in Section 2.6.

The results of two groundwater monitoring visits carried out are shown in the table below.

Date	Borehole No	Depth to groundwater (m) [Level (m OD)]
16/10/2020	1	0.69 [21.42]
	2	0.98 [21.50]
	3	0.33 [21.96]
12/11/2020	1	0.75 [21.36]
	2	0.82 [21.66]
	3	0.38 [22.91]

4.5 Soil Contamination

The table below sets out the values measured within the three samples of made ground and single sample of natural soil; all concentrations are in mg/kg unless otherwise stated.

Determinant	BH1 0.20 m Made Ground	BH2 0.60 m Made Ground	BH2 1.30 m Natural soil	BH3 0.20 m Made Ground
pH	11.2	7.9	7.6	9.9
Arsenic	20	11	13	11
Cadmium	0.4	< 0.2	< 0.2	< 0.2
Chromium	28	29	49	20
Copper	41	30	9.9	28
Mercury	1.5	0.6	< 0.3	< 0.3
Nickel	24	17	25	16
Lead	**3400**	210	23	140
Selenium	< 1.0	< 1.0	< 1.0	< 1.0
Zinc	90	84	59	90
Total Cyanide	< 1	< 1	< 1	< 1
Total Phenols	< 1.0	< 1.0	< 1.0	< 1.0
Sulphide	6.8	< 1.0	< 1.0	< 1.0
Total TPH	< 10	23	130	< 10
Naphthalene	< 0.05	< 0.05	< 0.05	< 0.05

Determinant	BH1 0.20 m Made Ground	BH2 0.60 m Made Ground	BH2 1.30 m Natural soil	BH3 0.20 m Made Ground
Benzo(a)pyrene	< 0.05	< 0.05	< 0.05	< 0.05
Total PAH	< 0.80	< 0.80	< 0.80	< 0.80
Total organic carbon %	0.8	0.7	0.4	0.6

Four samples of made ground were also screened for the presence of asbestos and none was detected.

4.5.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. Contaminants of concern are those that have values in excess of generic human health risk-based guideline values, which are either the CLEA[6] Soil Guideline Values where available, the Suitable 4 Use Values[7] (S4UL) produced by LQM/CIEH calculated using the CLEA UK Version 1.06[8] software, or the DEFRA Category 4 Screening values[9], assuming a residential end use without plant uptake. The key generic assumptions for this end use are as follows:

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be a young female child aged 0 to 6 years old;
- that the exposure duration will be six years;
- that the critical exposure pathways will be direct soil and indoor dust ingestion, skin contact with soils and dust, and inhalation of dust and vapours; and
- that the building type equates to a two-storey terraced house.

It is considered that these assumptions are suitable for this generic first assessment of this site. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

Where contaminant concentrations are measured below the generic screening value it is considered that they pose an acceptable level of risk and thus further consideration of these contaminant concentrations is not required. However, where concentrations are measured in excess of these generic screening values there is considered to be a potential that they could pose an unacceptable risk and thus further action will be required which could include:

- additional testing to zone the extent of the contaminated material and thus reduce the uncertainty with regard to its potential risk;

6 *Updated Technical Background to the CLEA Model (Science Report SC050021/SR3) Jan 2009* and Soil Guideline Value reports for specific contaminants; all DEFRA and Environment Agency.
7 *The LQM/CIEH S4Uls for Human Health Risk Assessment* S4UL3065 November 2014
8 Contaminated Land Exposure Assessment (CLEA) Software Version 1.06 Environment Agency 2009
9 CL:AIRE (2013) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Final Project Report SP1010 and DEFRA (2014) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Policy Companion Document SP1010

- site specific risk assessment to refine the assessment criteria and allow an assessment to be made as to whether the concentration present would pose an unacceptable risk at this site; or
- soil remediation or risk management to mitigate the risk posed by the contaminant to a degree that it poses an acceptable risk.

The results of the contamination testing have revealed a single elevated concentration of lead within the samples of made ground tested. All other contaminants were found to be below their respective generic guideline value.

This assessment is based upon the potential for risk to human health, which at this site is considered to be the critical risk receptor. The results are discussed in detail in Section 2 of this report.

Part 2: DESIGN BASIS REPORT

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations with respect to foundation options and contamination issues.

5.0 INTRODUCTION

It is understood that it is proposed to construct a single level basement beneath the existing lower ground floor level of the building, which will include a swimming pool.

Formation level for the proposed basement is at around 16.5 m OD, corresponding to a depth of around 7.5 m below ground level. No areas of soft landscaping are planned and the site will remain in residential use.

6.0 GROUND MODEL

The desk study findings indicate that the site has been developed since the mid-19th Century and has only had a residential or office use for its entire known developed history. It is therefore not considered to have a potentially contaminative history. On the basis of the fieldwork, the ground conditions at this site can be characterised as follows:

- below a variable but limited thickness of made ground, Lynch Hill Gravel is present over London Clay, which was proved to the maximum depth investigated of 10.00 m below lower ground floor level (12.11 m OD);
- made ground, of variable composition and typically with fragments of brick, extends to depths of between 0.40 m (21.89 m OD) and 0.90 m (21.58 m OD);
- the Lynch Hill Gravel generally comprises silty sandy slightly gravelly clay, and extends to depths of between 1.00 m (21.11 m OD) and 1.70 m (20.78 m OD);
- the underlying London Clay comprises firm to stiff fissured clay with selenite and occasional pockets of silt, and was proved to the maximum depth of the investigation, of 10.00 m below lower ground floor level (12.11 m OD);
- groundwater was not encountered during the investigation and subsequent monitoring after a period of approximately one week has recorded groundwater to be present at a shallowest depth of 0.33 m below lower ground floor level (21.96 m OD) within the gravel; and
- the contamination testing has measured a single elevated concentration of lead within one of the samples of the made ground tested, taken from Borehole No 1.

7.0 ADVICE AND RECOMMENDATIONS

It is understood that the new basement will extend to a maximum depth of approximately 7.5 m below existing street level which equates to around 5 m below the existing lower ground floor level and to a level of about 16.50 m OD. Formation level for the proposed basement should therefore be within the firm to stiff London Clay. On the basis of the fieldwork and subsequent monitoring, groundwater is likely to be encountered within the basement excavation.

7.1 Basement Construction

It is understood that the proposed basement will extend to a level of approximately 16.5 m OD, which is around 7.5 m below existing ground level and around 5 m below the existing lower ground floor level, such that formation level is likely to be within the firm to stiff London Clay.

The investigation has indicated that groundwater is likely to be encountered within the Lynch Hill Gravel, and shallow inflows of perched water should also be anticipated from within the made ground, particularly in the vicinity of existing structures. Any such inflows, from both the made ground and Lynch Hill Gravel, which is typically present as a thin layer of silty sandy gravelly clay rather than as a pure gravel, are likely to be relatively minor in nature and should be adequately dealt with through sump pumping, although it would be prudent for the chosen contractor to have a contingency plan in place to deal with more significant or prolonged inflows as a precautionary measure.

There are a number of methods by which the sides of the basement excavation could be supported in the temporary and permanent conditions. The choice of wall will be governed, to a large extent, by whether it is to be incorporated into the permanent works and have a load bearing function and also by the limited available access. The final choice will depend on a number of factors, including the need to protect nearby structures from movements, the required overall stiffness of the support system and the potential need to control groundwater movement through the wall in the temporary condition. In this respect the stability of the adjacent buildings will be paramount.

It is understood that the preferred method of retaining wall construction is through a mixture of underpinning and by casting reinforced concrete retaining walls in the same sequence as underpinned walls, which will have the benefit of minimising the plant required and maximising usable space in the new basement construction.

The proposed construction is anticipated to result in foundation depths being increased relative to the neighboring property of No 3 Hyde Park Place, and careful workmanship will be required to ensure that movement of the surrounding structures does not arise. The contractor should also be required to provide details of how they intend to control groundwater and instability of excavations, should it arise.

The ground movements associated with the basement excavation will depend on the method of excavation and support and the overall stiffness of the basement structure in the temporary condition. Thus, a suitable amount of propping will be required to provide the necessary rigidity. In this respect the timing of the provision of support to the wall will have an important effect on movements. The stability of the adjacent foundations will need to be ensured at all times and the existing foundations will need to be underpinned prior to construction of the proposed new basement or will need to be supported by new retaining walls. A Ground Movement Analysis has been carried out and is presented in Part 3 below.

7.1.1 Retaining Walls

The following parameters are suggested for the design of the permanent basement retaining walls.

Stratum	Bulk Density (kg/m³)	Effective Cohesion (c' – kN/m²)	Effective Friction Angle (Φ' – degrees)
Made Ground	1700	Zero	27
Lynch Hill Gravel	1800	Zero	30
London Clay	1950	Zero	23

Monitoring of the standpipes should be continued to assess the design water level but at this stage it would appear that groundwater may be assumed to be above basement level; the advice in BS8102:2009[10] should also be followed in this respect.

7.1.2 Basement Heave

The approximately 5 m deep excavation to form the proposed basement extension will result in a net unloading of around 100 kN/m², increasing to about 145 kN/m² for the proposed swimming pool, for which an excavation depth of around 7.2 m below the lower ground floor level will be required.

This unloading will result in elastic heave and long term swelling of the underlying clay soils, although these movements will to a certain extent be counteracted by the applied loads from the proposed development.

Further consideration is given to heave movements in Part 3.0 of this report.

7.2 Hydrogeological Assessment

The results from the ground investigation have indicated that groundwater is likely to be encountered within the basement excavation and is present at a depth of approximately 0.33 m below lower ground floor level (21.96 m OD).

The current development proposals include the construction of a basement that will extend to a depth of about 6.5 m (17.5 m OD) beneath street level, increasing to 8.7 m beneath street level (15.3 m OD) for the proposed swimming pool. The proposed depth of the new basement is such that it is likely to intercept groundwater flowing in a southerly direction within the Lynch Hill Gravel. Groundwater will be able to flow around the basement to the west, but not to the east, as flow in this location is already prevented by the basement beneath No 1 Hyde Park Place.

In conclusion, the basement will have a minor effect on groundwater flow, as groundwater will follow a pathway around the proposed basement to the west and should not build up significantly behind it. In addition, since the Lynch Hill Gravel is typically dominantly clay in this location, and of limited thickness, the movement of groundwater through this stratum is likely to be relatively slow and thus unlikely to be significantly affected.

Monitoring of the standpipes should be continued for as long as possible prior to construction to confirm this view.

10 BS8102 (2009) *Code of practice for protection of below ground structures against water from the ground*

7.3 Spread Foundations

Spread foundations, including underpinned foundations, bearing beneath basement formation level in the firm or stiff silty clay of the London Clay may be designed to apply a net allowable bearing pressure of 190 kN/m². This value incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.

7.4 Raft Foundation

It is understood that a basement raft foundation is the preferred foundation solution. Information provided by the consulting engineer, with respect to the proposed wall loads, indicates that line loads of 239 kN/m are anticipated, which will be applied to a basement raft following completion of the basement construction. Based on these wall loads, the pressure beneath the basement raft is likely to be approximately 70 kN/m², and when the unloading due to the basement excavation is taken into account, the net unloading is estimated to be around 30 kN/m², increasing to 75 kN/m² beneath the proposed swimming pool.

7.5 Basement Floor Slab

If a basement raft is not adopted, following the excavation of the single level basement, it is possible that the floor slab for the proposed basement will need to be suspended over a void or layer of compressible material to accommodate the anticipated heave, unless the slab can be suitably reinforced to cope with these movements. Further assessment should be carried out once the details have been finalised.

7.6 Shallow Excavations

On the basis of the borehole findings it is considered that shallow excavations for foundations and services that extend through the made ground and into the Lynch Hill Gravel are unlikely to remain stable in the short term, especially where groundwater is encountered. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides considered in order to comply with normal safety requirements.

Inflows of groundwater into shallow excavations should be anticipated; seepages may be encountered from localised perched water tables within the made ground, particularly in the vicinity of existing foundations, and should be anticipated at the base of the Lynch Hill Gravel. Such inflows should be suitably controlled by sump pumping.

7.7 Effect of Sulphates

Chemical analyses carried out on selected samples for water soluble sulphate have been compared with of Table C2 of BRE Special Digest 1: SD1 Third Edition (2005) in order to determine the sulphate class and are summarised in the table below. The assessment has been based on mobile groundwater conditions and the guidelines contained in the above digest should be followed in the design of foundation concrete.

Stratum	No of samples	pH	SO_4 (mg/l)	Design Sulphate Class	ACEC Class
Made Ground	3	7.9 – 11.2	44 - 330	DS-1	AC-1
Lynch Hill Gravel	1	7.6	140	DS-1	AC-1
London Clay	2	8.2, 8.3	1500, 1700	DS-3	AC-3

7.8 Contamination Risk Assessment

The desk study has indicated that the site has not had a significantly potentially contaminative history, having had a residential or office use throughout its known developed history. Of the four samples taken, only one was found to contain an elevated concentration of any contaminants; the sample of made ground from 0.20 m in Borehole No 1 contained 3400 mg/kg of lead, in comparison to a screening value of 310 mg/kg.

The source of the lead contamination is unknown, but the made ground in this location was noted as containing fragments of extraneous material including coal and it is considered likely that fragments of such material could account for the elevated concentrations. As a result, the lead is not likely to be in a soluble state and should not, therefore, pose a risk to adjacent sites, groundwater or buried services.

It is proposed to excavate a basement beneath the site, and as a result, the made ground will be removed, including the area from which the sample was taken. In addition, end users will be effectively isolated from any potential contamination by the house and hardstanding. No pathway and no risk to end users is therefore considered to exist, although the contamination could pose a risk to site workers during the ground works. These risks are further assessed below.

7.8.1 Protection of Site Workers

Site workers should be made aware of the potential contamination and a programme of working should be identified to protect workers handling any soil. The method of site working should be in accordance with guidelines set out by HSE[11] and CIRIA[12] and the requirements of the Local Authority Environmental Health Officer.

A watching brief should be maintained during the site works and if any suspicious soil is encountered, it should be inspected by a suitably qualified engineer and further testing carried out if required.

7.8.2 Protection of Buried Services

It is unlikely that services are at risk from the contamination noted in the made ground. However, details of any proposed protection measures for buried plastic services will in any case need to be approved by the EHO and the relevant service authority prior to the adoption of any scheme.

7.9 Waste Disposal

Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste classification is a staged process and this investigation represents the preliminary sampling exercise of that process. Once the extent and location of the waste that is to be removed has been defined, further sampling and testing may be necessary. The results from this ground investigation should be used to help define the sampling plan for such further testing, which could include WAC leaching tests where the totals analysis indicates the soil to be a hazardous waste or inert waste from a contaminated site. It should

11 HSE (1992) HS(G)66 *Protection of workers and the general public during the development of contaminated land* HMSO
12 CIRIA (1996) *A guide for safe working on contaminated sites* Report 132, Construction Industry Research and Information Association

however be noted that the Environment Agency guidance WM3[13] states that landfill WAC analysis, specifically leaching test results, must not be used for waste classification purposes.

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE[14] guidance, will need to be disposed of to a licensed tip. Waste going to landfill is subject to landfill tax at either the standard rate of £94.15 per tonne (about £175 per m^3) or at the lower rate of £3.00 per tonne (roughly £5.50 per m^3). However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring soil and stones, which are accurately described as such in terms of the 2011 Order, would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the EA it is considered likely that the soils encountered during this ground investigation, as represented by the chemical analyses carried out, would be generally classified as follows;

Soil Type	Waste Classification (Waste Code)	WAC Testing Required Prior to Landfill Disposal?	Current applicable rate of Landfill Tax
Made ground BH2 & BH3	Non-hazardous (17 05 04)	No	£94.15/tonne (Standard rate)
Made Ground BH1	Hazardous (17 05 03)	Yes	Discuss with receiving landfill. Hazardous classification is due to lead content
Natural soils	Inert (17 05 04)	Should not be required but confirm with receiving landfill	£3.00 / tonne (Reduced rate for uncontaminated naturally occurring rocks and soils)

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[15] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite prior to excavation by sufficiently characterising the soils insitu prior to excavation.

The above opinion with regard to the classification of the excavated soils is provided for guidance only and should be confirmed by the receiving landfill once the soils to be discarded have been identified.

The local waste regulation department of the Environment Agency (EA) should be contacted to obtain details of tips that are licensed to accept the soil represented by the test results. The tips will be able to provide costs for disposing of this material but may require further testing.

13 Environment Agency 2015. *Guidance on the classification and assessment of waste.* Technical Guidance WM3 First Edition
14 CL:AIRE March 2011. *The Definition of Waste: Development Industry Code of Practice* Version 2
15 Environment Agency 23 Oct 2007 *Regulatory Position Statement Treating non-hazardous waste for landfill - Enforcing the new requirement*

Part 3: GROUND MOVEMENT ANALYSIS

This section of the report comprises an analysis of the ground movements arising from the proposed basement and foundation scheme discussed in Part 2 and the information obtained from the investigation, presented in Part 1 of the report.

8.0 INTRODUCTION

It is understood that it is proposed to construct a single-storey basement beneath the full footprint of the existing lower ground floor of the building; in addition, a deeper excavation for a swimming pool will be created alongside the party wall with the adjoining No 3 Hyde Park Place.

The sides of an excavation will move to some extent regardless of how they are supported. The movement will typically be both horizontal and vertical and will be influenced by the engineering properties of the ground, groundwater level and flow, the efficiency of the various support systems employed during underpinning and the efficiency or stiffness of any support structures used.

An analysis has been carried out of the likely movements arising from the proposed excavation and the results of this analysis have been used to predict the effect of these movements on surrounding structures.

8.1 Basis of Ground Movement Assessment

The search of planning records held by City of Westminster revealed that all of the neighbouring properties have existing lower ground floor levels, and that the adjoining No 1 Hyde Park Place has an additional basement level beneath its lower ground floor level. The depth of these lower ground floor levels has been assumed to be consistent across the adjoining and adjacent properties, corresponding to a level of around 22.50 m OD, and the immediately surrounding area has been assumed to be broadly level.

The proposed basement beneath No 2 Hyde Park Place will extend beneath the full footprint of the building, with a depth of around 5.0 m below the existing lower ground floor level extending to a level of 17.50 m OD, increasing to around 7.20 m below lower ground floor level at a level of about 15.30 m OD for the proposed swimming pool alongside the party wall with the adjoining No 3 Hyde Park Place. As a result, the neighbouring properties are considered to represent sensitive structures. The level of the adjoining basement beneath No 1 Hyde Park Place is understood to be approximately equal to the level of the proposed basement beneath No 2, at around 17.50 m OD, but the proposed swimming pool will extend below the depth of this basement, such that the adjoining No 1 Hyde Park Place is considered to represent a potentially sensitive structure.

The exact nature of the foundations of the neighbouring properties is not known, so it has been conservatively assumed that they are supported on relatively shallow spread foundations, at depths of around 0.50 m below their respective floor levels.

8.2 Construction Sequence

The following sequence of operations has been derived to enable analysis of the ground movements around the basement, both during and after construction, and is based on the information provided by the structural engineer.

1. Install underpins to the existing walls;
2. cast ground floor slab;
3. excavate to basement and pool formation levels;
4. install basement slab; and
5. cast internal walls and liner walls;

When the final excavation depths have been reached the permanent works will be formed which, from the information provided, are understood to comprise reinforced concrete walls with a drained cavity lining discharging to a sump pit. Reinforced concrete will be used for the proposed basement raft slab, the level of which will vary across the basement, as a result of the proposed swimming pool.

It is understood that underpinning of the existing boundary walls will take place in a 'hit and miss' sequence, in stages to be agreed with the temporary works engineer and under party wall agreement. Underpinning should generally be undertaken in short sections not exceeding 1.00 m to 1.20 m in length, with no adjacent pin to be excavated until a minimum of 48 hours after the adjacent pin has been cast and dry-packed placed, with the sides of the excavation adequately shored and propped.

The detail of the support provided to adjacent walls is beyond the scope of this report at this stage and the structural engineer will be best placed to agree a methodology with the basement contractors once appointed.

The individual panel widths of the liner wall will need to be adequately laterally propped and sufficiently dowelled together, and the concrete will need to be cast and adequately cured prior to excavation of the basement and removal of the formwork and supports. It is assumed that the corners of the excavation will be locally stiffened by cross-bracing or similar and that the new retaining walls will not be cantilevered at any stage during the construction process. It is assumed that adequate temporary propping of the new retaining walls, particularly at the top level, will occur at all times prior to the construction of permanent concrete floor slabs.

9.0 GROUND MOVEMENTS

An assessment of ground movements within and surrounding the excavation has been undertaken using the X-Disp and P-Disp computer programs licensed from the OASYS suite of geotechnical modelling software from Arup. These programs are commonly used within the ground engineering industry and are considered to be appropriate tools for this analysis.

The X-Disp and P-Disp programs have been used to predict ground movements likely to arise from the construction of the proposed basement. This includes the heave / settlement of the ground (vertical movement) and the lateral movement of soil behind the proposed retaining walls (horizontal movement).

For the purpose of these analyses, the corners have been defined by x and y coordinates, with the x-direction parallel with the front and rear walls of the property, whilst the y-direction is parallel with the side / party walls. Vertical movement is in the z-direction.

For this movement analysis, the proposed basement has been modelled as a polygon, with maximum dimensions of 8.80 m by 29.90 m.

It is understood that propping will be provided during the construction of the basement and in the permanent condition, such that the walls can be considered to be stiff for the purpose of the ground movement modelling.

The full outputs of all the analyses can be provided on request, but samples of the output movement contour plots are included within the appendix.

9.1 P-Disp Model

Unloading of the underlying London Clay will take place as a result of the excavation of the proposed basement and the reduction in vertical stress will cause heave to take place. Undrained soil parameters have been used to estimate the potential short-term movements, which include the "immediate" or elastic movements as a result of the basement excavation. Drained parameters have been used to provide an estimate of the total movement.

The excavation of an approximately 5.0 m thickness of soil for the proposed basement will result in a net unloading of around 100 kN/m^2, increasing to about 145 kN/m^2 for the proposed swimming pool, for which an excavation depth of around 7.2 m below the lower ground floor level will be required.

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data and we have used a well-established method to provide our estimates. This relates values of E_u and E', the undrained and drained stiffness respectively, to values of undrained cohesion, as described by Padfield and Sharrock[16] and Butler[17] and more recently by O'Brien and Sharp[18]. Relationships of $E_u = 750\ C_u$ and a ratio of E' to Eu of 0.75 for the cohesive soils and 2000 x SPT 'N' for granular soils have been used to obtain values of Young's modulus.

The soil parameters used in this analysis and tabulated below have been primarily derived from the nearby BGS data and GEA investigations. For the purpose of the assessment ground level has been set at the lower ground floor level of No 2 Hyde Pak Place, at around 22.50 m OD.

16 Padfield CJ and Sharrock MJ (1983) *Settlement of structures on clay soils*. CIRIA Special Publication 27
17 Butler FG (1974) *Heavily overconsolidated clays: a state-of-the-art review*. Proc Conf Settlement of Structures, Cambridge, 531-578, Pentech Press, Lond
18 O'Brien AS and Sharp P (2001) *Settlement and heave of overconsolidated clays - a simplified non-linear method*. Part Two, Ground Engineering, Nov 2001, 48-53

Stratum	Depth Range (m)	Level (m AOD)	Cu (KN/m²)	Eu (KN/m²)	E'(KN/m²)
Lynch Hill Gravel	0.0 to 1.5	22.5 to 21.0	-	-	40,000
London Clay	0.0 to 53.5	21.0 to -31.0	53.5 to 441	40,000 to 330,940	30,000 to 248,200

A rigid boundary for the analysis has been set at the base of the London Clay, at a depth of 53.50 m below ground level (-31 m OD). An increase in cohesion of 7.5 kN/m^2 for each metre of depth has been adopted to provide an estimate of the likely strength profile within the London Clay Formation at depth.

Information provided by the consulting engineer, with respect to the proposed wall loads, indicates that line loads of 239 kN/m are anticipated, which will be applied to a basement raft following completion of the basement construction. Based on these wall loads, the pressure beneath the basement raft is likely to be approximately 70 kN/m², and when the unloading due to the basement excavation is taken into account, the net unloading is estimated to be around 30 kN/m², increasing to 75 kN/m² beneath the proposed swimming pool.

An assessment of the potential behaviour of these foundations has been included within the analysis, with a staged approach to the modelling adopted to reflect the change in the way the loads are applied during the course of construction.

9.2 Ground Movements – Surrounding the Basement

Settlement of the soil behind the new underpins may occur during installation due to the excavation in front of the wall causing the wall to deflect. For an underpinned wall this movement is likely to be small as the wall will be subject to a continued vertical loading from the structure above, which will also act as additional support at ground level. The party wall with No 1 Hyde Park Place is understood to have already been underpinned to form the basement beneath this property. The level of this adjoining basement is understood to be approximately equal to the level of the proposed basement beneath No 2, at around 17.50 m OD, thus it is assumed that the new basement slab will simply be doweled into the existing underpinning. Open cut techniques may also be required to form some of the perimeter walls of the proposed swimming pool. The magnitude of the settlement will be controlled to a large extent by the quality of workmanship of the underpins and by the existing building that is likely to provide additional rigidity.

It is assumed that suitable propping will be provided during the construction of the basement and in the permanent condition, such that the walls can be considered to be stiff for the purpose of the ground movement modelling.

9.2.1 Installation Phase

For the X-Disp analysis, the installation curves for the panel-like planar diaphragm wall in sand within CIRIA report C760[19], have been adopted as most appropriate for the soil movement relationship for walls installed by underpinning techniques.

The short-term behaviour of the proposed underpinning under vertical load during the early stages of construction (Stage 1) has been obtained from P-Disp and imported into X-Disp, to enable a damage assessment to be undertaken of all the potential movements.

19 Gaba, A, Hardy, S, Powrie, W, Doughty, L and Selemetas, D (2017) *Embedded retaining walls – guidance for economic design* CIRIA Report C760

9.2.2 Excavation Phase

Settlement of the soil behind the new underpins / retaining wall may occur due to the excavation in front of the wall causing the wall to deflect. The party walls will however be subject to a continued vertical loading from the structure above, which will also act as additional support at ground level, and will be fully propped on exposure, such that potential deflections during the excavation phase are not considered to be significant. However, the horizontal ground movement curve for 'excavation in front of a stiff wall in stiff clay' has been adopted to provide a conservative assessment and account for any potential movements as a result of this construction technique.

In order to address the potential impact of the proposed excavations, the vertical movements obtained from the excavation and subsequent long-term stages of the P-Disp analysis (Stages 2 to 4) have been imported into X-Disp to enable a damage assessment to be undertaken of all the potential movements.

9.2.3 Results

The movements predicted by the combined X-Disp and P-Disp analysis are summarised in the table below; the results are presented below and in subsequent tables to the degree of accuracy required to allow predicted variations in ground movements around the structure to be illustrated, but may not reflect the anticipated accuracy of the predictions.

Stage 1 (Short-term movements from installation of proposed underpinning)

Phase of Works	Wall Movement (mm)*	
	Vertical Heave / Settlement	Horizontal Movement
Immediately behind wall	6.0 to 7.0	2.0 to 4.0
At 5 m from wall	0.0-2.0	0.0-2.0
At 10 m from wall	<1.0	<1.0

**A positive number denotes settlement, whilst a negative number denotes heave.*

Stage 2 (Short-term movements following bulk excavation)

Phase of Works	Wall Movement (mm)*	
	Vertical Heave / Settlement	Horizontal Movement
Immediately behind wall	7.0 to 8.0	7.5 to 15.0
At 5 m from wall	2.0to 6.0	5.0 to 12.5
At 10 m from wall	1.0 to 5.0	2.5 to 7.5

**A positive number denotes settlement, whilst a negative number denotes heave.*

Stage 3 (Short-term movements following raft construction)

Phase of Works	Wall Movement (mm)*	
	Vertical Heave / Settlement	Horizontal Movement
Immediately behind wall	7.0 to 8.0	7.5 to 15.0
At 5 m from wall	2.0 to 6.0	5.0 to 12.5
At 10 m from wall	1.0 to 5.0	2.5 to 7.5

**A positive number denotes settlement, whilst a negative number denotes heave.*

Stage 4 (Total movements following completion of development)

Phase of Works	Wall Movement (mm)*	
	Vertical Heave / Settlement	Horizontal Movement
Immediately behind wall	7.0 to 8.0	7.5 to 15.0
At 5 m from wall	3.0to 7.0	5.0 to 12.5
At 10 m from wall	1.0 to 5.0	2.5 to 7.5

**A positive number denotes settlement, whilst a negative number denotes heave.*

9.3 Ground Movements within the Excavation (Heave / Settlement)

9.3.1 Results

The P-Disp analysis indicates that short-term heave resulting from the basement excavation is likely to be in the order of 7.0 mm, some of which is likely to be recovered following construction of the proposed raft foundation, whilst up to 6.0 mm of settlement is anticipated beneath the proposed underpinning.

In the long term, following completion of the basement construction and the distribution of the loads across the proposed basement raft, up to 3 mm of settlement is estimated to occur in some locations. The potential movements are summarised in the table below.

Location	Movements (mm) Heave is -ve and Settlement +ve			
	Short-term Movements			Total Movements
	Stage 1	Stage 2	Stage 3	Stage 4
Centre of proposed basement	2.0	-7.0	-3.0	-3.0
Centre of proposed pool	2.0	-6.0	-3.0	-4.0
Edge of proposed basement / Underpinning	3.0 to 6.0	-1.0 to 4.0	-1.0 to 3.0	-1.0 to 3.0

Stage 1 = Wall Installation; Stage 2 = Wall installation & bulk excavation; Stage 3 = Completion of basement box and application of raft loading; Stage 4 = Total movements following completion of development.